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Incidence of microbial infection associated with venous and urinary catheters in cancer patients

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Abstract

Background: Cancer patients are highly susceptible to microbial infections, particularly those caused by multidrug-resistant (MDR) hospital-acquired bacteria. Such infections pose a serious threat to immunocompromised individuals and complicate treatment decisions. Understanding the epidemiology of these pathogens and their antibiotic susceptibility patterns is therefore essential for improving patient outcomes. This study aimed to identify microorganisms isolated from venous and urinary catheters in cancer patients and evaluate their susceptibility to commonly used antibiotics.

Methods: Catheter tip samples were collected from patients at the National Cancer Institute, representing both genders and a wide age range. Samples were cultured on Blood agar, MacConkey agar, and Chocolate agar, then incubated at 37°C for 24–48 hours. Bacterial identification was performed using Gram staining, catalase and coagulase tests for Gram-positive species, and biochemical tests and API 20E for Gram-negative species. Antibiotic susceptibility testing followed Clinical and Laboratory Standards Institute (CLSI) guidelines using routinely used antibiotics.

Results: Of 56 catheter samples (central lines: 28; Port-a-caths: 10; urinary catheters: 18), microbial growth was detected in 83.9%. Bacterial isolates represented 83.9% of positive samples, while fungal isolates accounted for 16.1%. Gram-positive bacteria were more common (58.1%) than Gram-negative (25.8%). *Staphylococcus aureus* (38.8%) was the predominant Gram-positive isolate, followed by *Streptococcus* spp. (9.6%), *Bacillus* spp. (6.5%), and *Enterococcus faecalis* (3.2%). Among Gram-negative bacteria, *Klebsiella pneumoniae* (12.9%) was most frequent, followed by *Pseudomonas aeruginosa* (6.5%), *Serratia marcescens* (3.2%), and *Acinetobacter* spp. (3.2%). *S. aureus* isolates showed high susceptibility to amikacin, imipenem, and ciprofloxacin, while *K. pneumoniae* isolates were largely susceptible to ciprofloxacin and meropenem.

Conclusion: The findings demonstrate clear differences in antibiotic susceptibility between Gram-positive and Gram-negative pathogens. Further research should investigate biofilm formation, which may reduce antibiotic efficacy.

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I) INTRODUCTION:

Congenital esophageal stenosis (CES) is a rare congenital anomaly characterized by intrinsic narrowing of the esophageal lumen due to abnormal development of the esophageal wall during embryogenesis. [4] The incidence is estimated at 1 in 25,000–50,000 live births. [1,2] CES can present as a membranous web, fibromuscular thickening, or tracheobronchial remnants. [1,2,3]

Cancer patients face high risk of microbial infection, particularly with multi-drug-resistant bacteria in healthcare settings patients. These bacterial infections can be life-threatening and challenging in finding an effective treatment. To ensure successful patient outcomes, it is crucial to have a thorough understanding of microbial epidemiology. For over a decade, the epidemiology of bacteremia in cancer patients has primarily been associated with hematological diseases, particularly neutropenia [1, 2].

Various studies have stated the change in epidemiology between gram-positive and gram-negative bacteria as the main cause of bacteremia in cancer patients [3]. The usage of non-myeloablative drugs in neutropenia patients, the placement of a peripheral central line catheter and the risk factors of multidrug-resistant bacteria infection have worsened the diagnosis of the infection and delayed prescribing the appropriate antibiotic. Bacterial resistance to antibiotics has been linked to decreased immunity. Infections can pose a significant health challenge for cancer patients, particularly post-chemotherapy, with neutropenia which can make around 10-15% of solid tumor patients and over 80% of blood malignancy patients vulnerable to severe infections. Cancer treatments can compromise the immune system, rendering patients undergoing chemotherapy more susceptible to infections. The depletion of neutrophils can increase susceptibility to bacterial invasion and spread, hindering inflammatory responses and leading to potentially fatal infections [4].

Catheters like interventions are essential to ensure that patients receive treatment during their hospital stay [5] to provide treatment, nutrition, support renal function and to administer medications that difficult to be administered through peripheral veins. However, such interventions may cause complications such as venous occlusion or thrombosis and bloodstream infection, which can compromise patient safety and bloodstream infection, the main cause of which is bacteria [6]. Central venous catheter-associated bloodstream infection (CVC-ABI) can be defined as a laboratory-confirmed bloodstream infection that is not secondary to an infection elsewhere in the body and could occurs within 24 hours of catheter placement [7, 8].

It is increasingly used intravascular in cancer patients to administer chemotherapy drugs. CVC-ABI is one of the most common complications in patients and is associated with increased mortality rates, longer hospital stays, and increased costs [9, 10]. Intravascular catheter management in patients has changed over the past decade with increased use of peripherally inserted central venous catheters, tunneled catheters, and port reservoirs, and a decrease in peripheral central venous catheters. These changes, combined with recent changes in the epidemiology of CVC infection, have led to a significant increase in the number of CVC-ABI patients. Bloodstream Gram-positive bacteria, especially Staphylococcus aureus, remain the main cause of infection in the disease [11].

Depending on the pathogen, immediate removal of the IV catheter may be necessary, according to the guidelines classified by the Infectious Diseases Society of America in 2009, and in the case of uncomplicated bloodstream infections of Gram-negative bacteria associated with the catheter such as Enterobacter ales, rescue treatment with systemic antibiotics is recommended instead of immediate catheter removal [12]. Unsuccessful rescue treatment may eventually lead to unexpected infection and deterioration of the patient's clinical condition, leading to admission to the intensive care unit and may have a negative impact on the continuation of oncology treatment [13, 14]. In recent years, the use of peripherally inserted central catheters has increased significantly infections, especially in chemotherapy of cancer patients. This does not cause mechanical complications such as bleeding

associated with catheter placement and provides a longer stay compared to central catheters. Moreover, it provides ease of transfer from the hospital to home for intravenous treatment. Despite its benefits, it is often associated with severe complications such as catheter-related thrombosis or phlebitis. Compared to central catheters, bacterial infections are less common [15].

UTIs account for 12.9% of healthcare-associated infections and 23% of ICU infections, UTIs occur at a rate of 3-10% per day from catheterization and approach 100% within 30 days of hospitalization [16]. The occurrence of UTIs significantly impacts the clinical outcomes of the disease, including longer hospital stays, increased healthcare costs, and antibiotic overuse, as well as potentially increased mortality [17]. The presence of catheters creates a special environment for bacterial colonization and biofilm formation, which increases the risk of infection and impairs the effectiveness of treatment. According to the Infectious Diseases Society of America, catheter-associated urinary tract infection is defined by the following criteria: a catheter in place for more than two days, frequent urination, suprapubic pain, fever, and a urine culture containing more than 10*5 colony forming units of a single bacterial species [18].

The current study addressed microbial infections in venous and urinary catheters of cancer patients to identify the causative microorganisms and evaluate their susceptibility to most used antibiotics.

II) Methods

A) Study design

The study included venous and urinary catheter samples of patients attending the National Cancer Institute randomly during the period 2020 to 2022 of both sexes and different age groups.

B) Sample collection

The samples (tips of catheters) were received at the microbiology laboratory of the National Cancer Institute, Misurata, Libya. Tip of catheters were impregnated in normal saline solution for half an hour to ensure that the sample was taken from inside and outside the tip. Then, a swab was dipped in the saline and was inoculated onto Blood agar, MaCconkey agar, and Chocolate agar plates. The plates were incubated at 37°Cfor 24-48 hours.

C) Bacterial diagnosis

Gram stain was used to differentiate between Gram-positive and Gram-negative bacteria, as well as catalase and coagulase tests to differentiate between positive bacterial species, in addition to biochemical tests, Analytical Profile Index 20E (API 20E) to identify negative bacterial species.

D) Susceptibility test

Susceptibility test was performed following Clinical and Laboratory Standards Institute (CLSI) guidelines. A bacterial suspension was made, and its turbidity was adjusted with McFarland solution (0.5). Using a cotton swab, a Hinton Mueller agar plate was inoculated, and the plate was left for 5 minutes to dry. The most used antibiotics (Fortress Diagnostic Limited, UK). were added as in the table (1) and incubated for 24 hours at 37°C [19].

Antibiotic	Concentration
Ciprofloxacin (CIP)	5 mcg
Imipenem (IMI)	10 µg
Amikacin (AK)	30mcg
Cefuroxime (CXM)	30mcg
Meropenem (MEM)	10mcg
Augmentin (AUG)	30mcg
Piperacillin/ Tazobactam (PRL)	30mcg
Cefotaxime (CTX)	30mcg
Doxycycline (DXT)	30mcg
Azithromycin (AZM)	30mcg
Bactrim (SXT)	1.25µg
Ceftazidime (CAZ)	30mcg

Table (1): antibiotics were used in the study.

E) Statistical Analysis

Microsoft Excel 16 was used to create appropriate Tables and Figures.

III) Result and Discussion

The study included 56 venous and urinary catheter samples from cases attending the National Cancer Institute, which were 28 central lines, 10 port-a-caths, 18 urine catheters. The results obtained from the current study showed that most of the microbial isolates were bacteria at a rate of 83.9%, while the fungal isolates were 16.1%. Gram positive bacteria was identified at a rate of 58.1%, which was higher than Gram negative bacteria (25.8%). The bacteria varied in their proportions, and the current study found that the percentage of positive bacteria was higher than the negative bacteria. This was consistent with a study in China [20], while it was not consistent with two studies in Turkey and Australia, in which the percentage of negative bacteria was higher [21, 22].

Isolated Gram-positive bacteria were S. aureus (38.8%), non-haemolytic Streptococcus spp. (9.6%), Bacillus spp. (6.5%) Enterococcus faecalis (3.2%). Isolated Gram-negative bacteria represented Klebsiella pneumoniae (12.9%), Pseudomonas aeruginosa (6.5%). Serratia marcescens (3.2%) and Acinetobacter spp (3.2%); as shown in the Table (1). S. aureus and Klebsiella pneumoniae were the most presented bacteria in the intravenous catheter, while yeasts were the most prevalent microorganism in the urinary catheter. Other studies also found that the most prevalent bacteria were Gram-positive, compared to Gram-negative bacteria [20, 22]. This study results showed that K. pneumonae was the most isolated Gram-negative bacteria, while other studies found E. coli was the most prevalent Gram-negative bacteria [20, 22]. this was not the case in the current study. The reason beyond that could be cancer patient more susceptible to be infected by multi-drug bacteria like K. peneumoniae.

Type of microbes	Number	PERCENT (%)
Gram negative	8	25.8
Klebsiella pneumoniae	4	12.9
Pseudomonas aeruginosa	2	6.5
Serratia marcescens	1	3.2
Acinetobacter spp	1	3.2
Gram positive	18	58.1
Staphylococcus aureus	12	38.8
Streptococcus spp	3	9.6
Enterococcus faecalis	1	3.2
Bacillus spp	2	6.5
Fungi		
Yeasts	5	16.1
Total	31	100

Table (1): Microbial isolates obtained from venous and urinary catheters.

These results were like results that were obtained from a study was done in Turkey that *S. aureus* was more prevalent in intravenous catheters. However, the results obtained in this study disagreed other studies as the most isolated gram negative was *K. pneumoniae* instead of *P. aeruginosa* and fail to isolate yeasts. [23] [24]. The current study results were similar to a previous study was done in China as yeasts were isolated from intravenous catheters a rate of 24.4% [25], The current study found that *S. aureus* the most prevalent organism on urinary catheterization. Similar results was stated by a study was done in Spain and China [11, 15], while, studies were performed in Saudi Arabia and Algeria as their results showed that negative bacteria were higher than positive bacteria.. These studies revealed that the most common bacteria were *E. coli*, *Enterococcus faecalis, P. aeruginosa, S. aureus* [26, 27], The current study showed that yeasts growth and positive bacteria were more

prevalent than negative bacteria than other studies [11, 15] and that could be due to the participants were in this study were cancer patients

As for the results obtained from antibiotics susceptibility test for Gram positive bacteria, *S. aureus* isolates were susceptible to amikacin, imipenem and ciprofloxacin. *Streptococcus spp.* isolates were sensitive to most antibiotics except amikacin and pipracillin. An *Enterococcus faecalis* isolate was resistant to all used antibiotics. *Bacillus* spp isolates were sensitive to most antibiotics except augmentin and pipracillin (Figure 1).

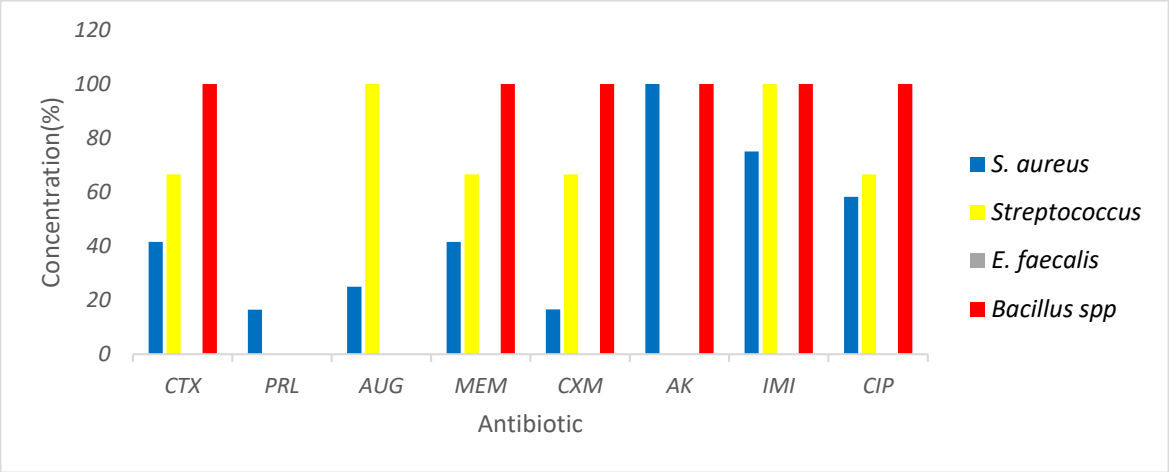

Figure (1): Antibiotic susceptibility of Gram-positive bacteria isolated from catheters.

In regarding to Gram negative bacteria, *K. pneumoniae* isolates were susceptible to ciprofloxacin and meropenem, while *P. aeruginosa* was sensitive to ceftazidime and ciprofloxacin. *Serratia marcescens* was sensitive to most antibiotics except Bactrim and meropenem. *Acinetobacter spp* was sensitive to the antibiotic meropenem only as shown in Figure 2.

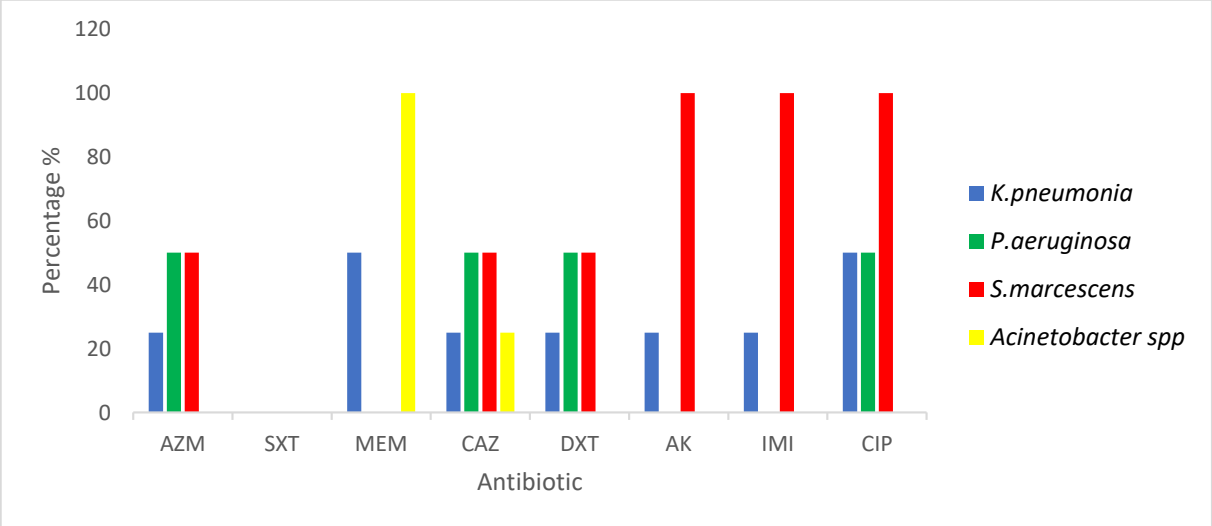

Figure (2): Antibiotic sensitivity of Gram-negative bacteria isolated from catheters.

It was found in this study that the most effective antibiotics on all obtained bacterial isolates (Gram positive and negative) were amikacin, imipenem and ciprofloxacin. This was similar to studies that was found most of isolates were sensitive to ceftazidime, ciprofloxacin and imipenim [26] [23], In addition, most of the bacteria were resistant to many antibiotics, similar to the study in Turkey [21].

IV) Conclusions:

Catheters, whether intravenous or urinary, play an important role in transmitting infection, and early use of the appropriate antibiotic could help prevention of infections. It was found that most prevalent bacteria S. aureus and K. pneumoniae. Antibiotics susceptibility testing showed that there was an effect on the isolated bacteria, especially amikacin, imipenem and ciprofloxacin. Further studies may help reducing the infection like evaluation of the possibility of bacteria isolated from intravenous and urinary catheters to form biofilms as biofilms could trap susceptible antibiotic to eradicate the pathogen from the host.

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